Modernization of the Cooperative Observer Network

Plan Functional Requirements Document

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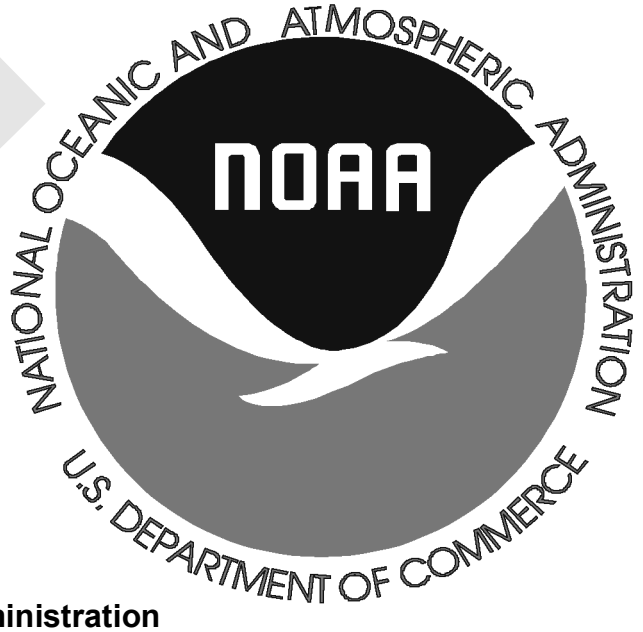

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service

Signature/Approval Page

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Plan Functional Requirements Document

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U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service

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Functional Requirements for the Modernization of the Cooperative Observer Network — Baseline Sites

1 Purpose

The National Oceanic and Atmospheric Administration's (NOAA) National Weather Service (NWS) is responsible for the operation and maintenance of a nationwide volunteer climate and weather observation network known as the Cooperative Observer Network (COOP). This Plan Functional Requirements Document (PFRD) sets forth the technical requirements of the NWS program to modernize the COOP network based on the Program Development Plan signed on 31 March 2004 by NWS Director D. L. Johnson.

1.1 System Overview

COOP is the largest and oldest weather and climate-observing network in the world, providing daily weather observations from over 11,500 stations nationwide. It is a unique observation network supported by volunteer observers. The Program Development Plan for COOP Modernization documents the requirements to modernize many of the existing COOP sites and add new sites to achieve the desired network spatial density. All modernized COOP sites will provide five-minute observations in real-time. Baseline stations are stations that automatically report temperature and precipitation data (including human-added elements of liquid equivalent of freezing and frozen precipitation, snowfall, snow depth and, where required, river stage levels). Enhanced stations are those sites where additional sensors have been added due to changing requirements and/or the support of NWS partners. Sections 3 through 26 define the requirements for baseline and enhanced Cooperative observing sites.

1.2 Vision

The program to modernize the Cooperative Observer Network will maintain the existing baseline measurements, and provide sufficient growth margin to allow for future expansion with additional sensors, resulting in enhanced sites that support a variety of applications. Additional sensors will be deployed as contract options. The system design for baseline sites includes the growth margin for these options, but not for the additional sensors themselves. The site configuration and communications network shall be sized to include these sensors without requiring a redesign. The modernized COOP network will increase the density of reporting stations, primarily in the western United States, enhance the suite of deployed sensors, and provide automated real time recording, reporting, and processing capabilities.

1.3 Categories of Modernized COOP Sites

About 7,500 sites in the continental United States and 500 sites in Alaska and Hawaii will be established during the modernization of the COOP network. At least 1,000 of the modernized sites are expected to become enhanced sites with additional sensors that meet the requirements of the United States Department of Agriculture. Other NWS partners no doubt will have requirements for additional equipment. Appendix A describes the sensor requirements for enhanced sites. Approximately half of the modernized COOP sites will be selected from existing

COOP sites and half the sites will be selected from new locations. The government is responsible for site standards and site selection of modernized COOP sites; these requirements are not part of this PFRD. However, on an annual basis, the Government will inform the maintenance contractor(s) of the sites the contractor(s) are responsible for each year.

Modernized COOP sites will be drawn from three categories of sites. Category-1 (CAT-1) sites are new sites where observation equipment did not exist. Category-2 (CAT-2) sites are current COOP sites that use legacy equipment. Category-3 (CAT-3) sites, owned or operated by a partner or potential partner of the NWS, are not part of the current COOP network; however, these sites operate at high professional standards, and are candidates for inclusion in the modernized COOP network. These three categories of sites may or may not have an on-site observer to augment the system information. The Government recognizes that the weather extremes at each location may require equipment configurations to be environmentally robust at a small percentage of locations. The environmental divisions that result are referred to as operating zones. Table of Site Categories provides an estimate of the quantity of baseline sites in each operating zone in the modernization program. The definition of the operating zones is described in Section 20. The Program Development Plan for COOP Modernization describes the implementation strategy.

Table 1. Site categories for the 8000 modernized COOP sites.

	Moderate Weather	Extreme Cold Weather	Extreme Warm Weather	Extreme Cold and Warm
CAT-1 with Observer	~1,550	~300	~50	~100
CAT-1 without Observer	~1,600	~100	~200	~100
CAT-2 with Observer	~3,300	~300	~200	~200
CAT-2 without Observer	0	0	0	0
CAT-3 with Observer	unknown	unknown	unknown	unknown
CAT-3 without Observer	unknown	unknown	unknown	unknown

2 Document Overview

This PFRD sets forth the performance requirements, development, test, integration, and maintenance requirements of the modernized COOP network. ~~The contractor may add to or revise the documents listed in Appendix B, with approval from the Government, when~~

~~developing the formal system specification. [Not sure what this Appendix includes]~~

The requirements for sensor and algorithm performance at a Baseline Site in the modernized COOP network are listed in Sections 3 through 26. Appendix A lists the performance standards at an Enhanced Site. As a minimum, all modernized sites must meet the sensor and algorithm performance standards for a Baseline Site.

Certain items are listed as goals throughout the document. Goals may be met on a per site basis even though it may not be possible to meet them at all sites. For example, some sites may have communication capabilities, such as GOES or cellular telephones, which may allow certain goals to be met. Another example is the ability to download modernized COOP data via Very High Frequency radio into a nearby state-supported telecommunications network.

The term "To Be Determined" ("TBD") applied to a requirement means the contractor should determine the missing information in coordination with the Government. The term "To Be Supplied" ("TBS") means the Government will supply the missing information in the course of the contract. The term "To Be Refined" ("TBR") means the requirement may be reviewed by the contractor or the Government and may be coordinated with the Government during the course of the contract to improve the overall performance of the modernized COOP network. The term "Government Furnished Equipment" (GFE) is applied when the Government will supply the equipment or service.

3 System Definition

Baseline sites in the modernized COOP network will have automated sensors to measure and report temperature and precipitation. The data logger must be expandable to allow for additional sensors defined in Appendix A of this document. Sites with sensors in addition to those elements defined in Sections 3 through 26 are defined as Enhanced Sites in the modernized COOP network. A requirement exists for the modernized system to provide an ability to augment specified elements by a human observer. The five-minute observations will be formatted in a standardized report and transmitted at least hourly on a single report, or in a series of sequential reports from data collected within the past hour. The goal is to transmit data at intervals of 15 minutes or less.

4 Mandatory Elements

The following are mandatory observations from all baseline sites:

A. Ambient Air Temperature at 1.5 meters above ground.

B. Precipitation Accumulation (including freezing/frozen precipitation) at approximately 0.6 to 2.0 meters above ground.

5 Functions of the System

A. Observer Augmentation/Annotation,

B. Data Logging/Processing,

C. Transmission of Reports, and

D. Contractor Installation and Maintenance.

6 Ambient Air Temperature

The sensor and data logger must provide temperature measurements from every modernized COOP site. Each site must provide:

A. Twelve 5-minute temperature reports every hour. A 5-minute temperature report is obtained by:

i. Report a 1-minute temperature observation every minute, beginning with H+01. A 1-minute temperature observation is obtained by:

a. Sampling the temperature at least every 10 seconds for each minute.

b. Averaging the instantaneous samples.

ii. Every fifth minute, report the 1-minute temperature as the 5-minute temperature report.

B. Maximum and minimum (Max/Min) temperature reports from midnight to midnight local time.

i. Report the maximum and minimum 1-minute temperatures observed during the preceding 24 hours ending at midnight local time.

ii. Make the range of 1-minute reports extend from 0001 to 2400 local time.

iii. Time stamp the maximum and minimum measurements.

C. Average hourly temperature (for USDA evaporative algorithm).

i. Average the sixty 1-minute temperature reports beginning with H+01.

ii. Report the average hourly temperature in the 5-minute report at H+60.

6.1 Temperature Accuracy/Resolution

The range of temperatures for the sensor will extend from -65°C to +60°C. The accuracy and resolution are those reported in Table . Accuracy is defined as the range within which 99% of the measurement errors must lie during the lifetime of the sensor. The **goal** is to have an aspirated temperature sensor for warm weather operating zones, though that might not be possible during

the initial deployment. Rates of aspiration will be provided by the Government. The measurement error is the difference between the measured and true values of a parameter for any given observation. Accuracy is usually specified as ± B, which indicates the following explicit requirement: $-B < (X_M - X_T) < B$, where X_M and X_T are the measured and true values of the parameter X, respectively.

Table 2. Temperature Accuracy/Resolution.

Parameter	Units	Accuracy	Range	Resolution
Temperature	Degrees Celsius	±0.6°C ±0.3°C ±0.6°C	-65 to -46°C -46 to +50°C +50 to +60°C	0.06°C 0.06°C 0.06°C

6.2 Temperature Information Display

Sites with COOP observers require a method of displaying the temperature information at the observer's host site. The observer(s) must have a low cost (to the government), user-friendly method to attain current and maximum/minimum temperature data for local use. There is a large supply of GFE temperature displays available in the NWS Logistics and Supply Center; these may or may not be used for the modernized COOP network.

- Goal: wireless transmission of data from the sensor location to observer's host site.

7 Precipitation Accumulation

The sensor and data logger must provide accumulated precipitation measurements at each modernized COOP site. Each site must provide:

A. Twelve 5-minute precipitation accumulation reports every hour. A 5-minute precipitation accumulation report is obtained by:

   i. Report a value of precipitation accumulation every 5 minutes beginning with H+05.

B. A 24-hour accumulated precipitation report from midnight to midnight local time (primarily for use by the local host):

   i. Report the total accumulated precipitation for the "current day"

   ii. Report the total accumulated precipitation for the preceding 24 hours at midnight local time (i.e., for the 'previous day').

   iii. Make the range of data extend from 0001 to 2400 local time.

   iv. Reset precipitation accumulation each night at 2400 local time.

C. Accumulated precipitation reports for variable time intervals will be determined by GFE servers at the Data Ingest and Processing System.

7.1 Accuracy/Resolution for Precipitation Accumulation

The resolution must be 0.25 mm. The accuracy requirement is for ±0.51 mm or 4 percent of the hourly amount (whichever is greater). Any gauge must operate in an ambient air temperature range from -34°C to +49°C. Table displays the accuracy/resolution requirements.

Table 3. Accuracy/resolution for precipitation accumulation.

Parameter	Units	Accuracy	Range	Resolution
Precipitation Accumulation	mm	±0.51 mm or 4% of hourly amount (which ever is greater)	0 to 250 mm h^{-1}	0.25 mm

7.2 Annotation of the Precipitation Record

The ability must exist for manual annotations to the precipitation record. A record notation may be a time-related event or an informational note.

8 Augmentation

Human observers at modernized stations must be able to report manually any additional information that the system is incapable of providing automatically. This ability may be independent from the data logger or it may have an interface for the observer to transmit data.

A. Interfaces for the additional data may be defined as those points of connection between the modernized COOP network and a human. Thus, an auxiliary method must be in place for the human to report the data. The contractor should provide an estimate of requirements for space (both square footage of floor space and its volume) inside the host facility, and power requirements (power factor, peak load, etc.). If an interface uses data compression during transmittal of data, the compression shall be error free.

B. The interface shall provide the following elements to be reported from manual measurements:

i. Snow depth (6/24 hourly) using GFE

ii. Snowfall (6/24 hourly) using GFE

iii. Liquid equivalency of snow depth using GFE

iv. Nearby river gauge(s) data manually collected by a human using GFE

v. Other site-specific elements (TBD) using GFE.

C. Goal: The independent augmentation interface may use an internet form, such as the Automated B-91 internet form at some locations (GFE).

D. Goal: The special phenomena data stated in NWS Observing Handbook Number 2 will be digitized through an NWS approved code and provided through the human augmentation interface provided to each host (as required).

E. Goal: Wireless interface from the remote observing site to the observer's location.

9 Data Logging/Processing

A modern-day data logger is the heart and soul of the modernized COOP network. The data logger should have a capacity to accept input from no less than twelve sensors. The data logger used in the modernized COOP must have the following capabilities:

A. Storing and processing information.

i. The data logger must have memory storage to retain the 5-minute observations from twelve or more sensors for 35 a minimum of days. This storage must be upgradeable through Commercial Off-the-Shelf (COTS) memory or storage modules.

ii. The data logger must have built in logic and advanced mathematical functions for processing data. The functions may be in the operating system or hardware.

iii. The data logger must be programmable by Government personnel for quality assurance programs, sensor algorithms, sensor sampling frequencies and other programmable needs.

iv. The data logger must have a display with at least a 2-inch window and scrollable text or menu selections to enable viewing of sensor data by maintenance technicians.

B. Interface for sensors at Baseline Sites and Enhanced Sites. The data logger must have channels to accommodate sensors requiring:

i. Analog voltage input to a data logger

ii. Pulse input to a data logger

iii. Digital input to a data logger

iv. SDI-12 serial interface to a data logger

v. RS-232 interface to a data logger. There should be at least two communication ports.

vi. Input methods resulting from improvements in sensor technology.

vii. The data logger must be upgradeable to allow for additional channel capabilities through a *multiplexer* add-on device. This device should be modular COTS.

viii. Input from bio-chemical detection sensors (or a capacity to upgrade to allow input from such sensors).

ix. Input from a global positioning system sensor.

x. Input for an optional wireless transmitter from the sensor location to an observer's physical location.

C. The data logger must have an interface for the various methods of transmission of data without loss of data, even when data compression is used. The logger must:

i. Be capable of accepting software or hardware upgrades to support the proprietary requirements of various vendors.

ii. Be capable of supporting radio links, modem connections, wireless interfaces, GOES Data collection system transmitters, Meteo-burst transmitters, or other communication methods.

iii. Support two-way communications.

D. The data logger time stamps shall be accurate to within ±1 minute.

i. The data logger must have the ability accept remote updates to the clock.

ii. Goal: time should be accurate to within ±10 seconds after one month.

iii. Goal: a global positioning system clock is included in the data logger.

E. The data logger must have the capability to accept software changes from remote locations.

F. The data logger must have built in lightning protection.

G. The data logger software must be able to generate and transmit error messages, diagnostic messages, and alarm messages to facilitate real-time remote fault isolation and recovery.

H. Although baseline sites in the modernized COOP network require a 12-channel data logger, the modernized system should have flexibility to allow the contractor

to install data loggers with more than 24 channels where required, and when it is not practical to upgrade a 12-channel data logger. Section 26 describes the requirements for reserve resource capacity of the baseline data logger.

9.1 Local Archiving of Data

The data logger must have the ability to store at least 35 days of data. The data logger must have an interface to allow for local retrieval of the data. A technician interfacing through an RS-232 port may execute the retrieval of data or the data may be stored to a removable medium.

10 Transmission of Reports

The requirement is for hourly transmission of reports. The goal is for reports to be transmitted at least every 15 minutes. The reports may be transmitted from H+01 to H+60. A communications system will be GFE to automatically transmit the reports in real time in the most cost-effective way. The requirement is for end user receipt of reports 10 minutes after the time of the hourly transmission.

A. Goal: The goal is for reports to be transmitted at least every 15 minutes and possibly every 5 minutes. Each 15-minute transmission will contain three 5-minute reports.

B. The baseline communication system must be independent of any existing host site communication system, but flexible enough to take advantage of existing host site communications where feasible and agreed to by the host site volunteer.

C. In the case where existing host site communications are used, the host site must not interfere with hardware or software in the modernized COOP.

D. The method of communication chosen for any given interface to transfer data shall minimize the life cycle communication and maintenance costs. There may be one national communication solution or a variety because of local solutions (e.g., commercial phone service, GOES DCP, cell phone, DSL, LETS, etc.).

E. Goal: The system should provide two-way communication to allow remote monitoring for data downloading, data quality assurance, and maintenance actions.

F. Goal: The goal is for end user receipt of reports no more than 10 minutes from the time of the last observation.

10.1 Report Formats

All stations shall use a uniform format for transmission of reports. This format is recommended to be the ASCII or “Pseudo Binary” format. Each station shall be identified with a station identifier (Station Identifiers are GFE) in the transmitted message and a unique date/time for each observation. A method must exist for the reporting of elements augmented by the observer. The format of the entire observation (including human observations) must include null data sets

to account for the augmented elements. A contractor may identify other formats to be used. The Government shall be consulted for approval of the code format.

10.2 Encoding of Report

The reports shall be encoded to the NWS SHEF, XML or WMO BUFFR formats at a central collection point after transmission. The encoding will be government furnished. A contractor may identify other methods of acquiring data for the Government to evaluate.

10.3 Quality Assurance of Data

The Government shall provide data Quality Assurance (QA). This task will be conducted at a central collection point (or distributed collection sites) after post transmission encoding.

A. The data logger shall provide limited quality assurance to ensure compliance with data specifications.

B. The data logger shall at least provide real-time range and gross error checks of observations through programming instruction provided to the contractor by the Government.

C. The Government shall provide data QA after transmission. These procedures are described in the Program Development Plan for modernizing the COOP network and in related NWS directives.

10.4 End User Receipt of Reports

The reports need to go from the data logger through the transmission medium to a collection point(s) for encoding and QA, and then to the users. The encoding may occur at one central collection point and the QA at another, or the encoding and QA activities may occur on one or more central processor(s) prior to transmitting the observations to the end users. NWS users must receive the data via the AWIPS. External end users may receive the data via an internet central collection server or via the NWS Gateway and the Family of Services. The method of transmission should have no affect on the content of the observations.

A. The method for acquiring data from the medium of transmission must be able to meet the latency requirement of 10 minutes from transmission to end user.

B. The acquisition network may be government furnished or it may be furnished and maintained by the contractor.

11 Installation

Most of the National Cooperative Mesonet locations are on private property. Installations must be coordinated by the Government. Focal points for each affected WFO will be identified to the installer. A site survey must occur before installation. The site survey must include input from the observer, if any, the installer, and the Government. The installation and operation of National Cooperative Mesonet equipment shall not adversely impact the capabilities of any host

facility.

11.1 Power Requirements

Alternating current (AC) power may not be available at the station for the data logger. There is a need for an alternate power source allowing uninterrupted operation of the data logger. The alternate power source may not be a generator. The alternate power source (e.g., solar panel and Direct Current batteries) must fit within the footprint of the observing site and not interfere with the proper operation of the station. Battery voltage will be an element in each report.

A. All sites with AC power need an uninterruptible power supply (UPS) capable of powering the data logger for a limited time in the absence of host AC power. Different sites may use different UPS and recharging systems based on the site conditions (e.g., Arctic winter) to ensure operation for a minimum of 30 days.

B. The UPS system shall be rechargeable by either the host AC power or by a solar panel power supply. Sites not meeting the minimum definition of low sunlight conditions, as defined by the Regional Teams, for every month in the year shall be rechargeable by host AC power, even if a solar panel is also provided.

C. If a solar panel power supply is used to run and operate the data logger, then the solar panel shall be sized to provide sufficient UPS recharge capability to maintain operations under low sunlight conditions for a period to ensure data availability.

11.2 Siting Requirements

All installations must meet NWS standards for siting and exposure of equipment (See NWS Directive System Instruction 10-1302). The standard footprint for a National Cooperative Mesonet observing site is 10x16 feet, although this can be expanded under specific equipment requirements. The National Cooperative Mesonet Transition Program Manager will inform the contractor the locations where the footprint will be larger. The site must not be affected, or likely to be affected, by local environmental modifiers, (i.e., new construction, irrigation, etc.). NWS Observing Handbook Number 2 has additional information on footprints for COOP observing sites. External equipment shall have protective fencing thwarting theft, vandalism, and livestock or wildlife damage. Legacy equipment at existing sites (CAT-2 sites) replaced by National Cooperative Mesonet equipment shall be removed and shipped to the NWS Reconditioning Center in accordance with specifications, after a sufficient period of time has passed to allow continuity testing.

11.3 Site Acceptance

The supervising WFO or other designated NWS staff shall coordinate with the contractor to accept the site after installation. Unacceptable site installations shall be resolved by the NWS. A detailed site acceptance plan will be developed by the contractor and the Government.

11.4 Commissioning

Each new station will be commissioned by the NWS. The commissioning process will be in

compliance with National Weather Service Policy Directive 80-2.

12 Maintenance

Maintenance will be provided by the contractor. Reliability of the observing stations and the network's delivery of data which meets the accuracy requirements (referenced in this document) to the end user in real time shall be 96%. Local storage of the data must be 99 percent available. The contractor will perform calibration of the sensors as necessary and as agreed to with the Government. All calibration information will become part of the station's metadata file. The Government is responsible for directing the contractor to perform emergency maintenance. The contractor is responsible for responding to the direction of the Government and for performing routine maintenance. The following must be provided by the contractor:

A. Well-calibrated sensors. Maintenance technicians may have methods to calibrate selected sensors at the National Cooperative Mesonet sites, rather than removing the equipment solely for the purposes of calibration. This applies to calibration of the data logger, certain sensors (as agreed to by the Government and the contractor) , and the communication devices (where applicable).

B. Preventive maintenance on an agreed to schedule. The maintenance shall cover all the equipment on the station.

C. Non-routine and emergency maintenance as required and in response to trouble tickets generated by the Government. The National Cooperative Mesonet Operations Center will be the primary Government contact for the contractor on receiving notification of maintenance actions from the Government. Contractor maintenance response times to outages will be prioritized by site location, sensor type, and season. Prioritization schedules will be negotiated between the Government and the contractor before contract award.

D. Performance reliability and status reports for individual sensors, each station, and the network.

E. Solutions to trouble reports provided to the contractor by the Government.

F. The National Cooperative Mesonet sites shall be configured to allow hardware and software components to be repaired or replaced with the data loss not impacting specified National Cooperative Mesonet data availability requirements. Approved procedures will predetermine repair or replacement of hardware.

G. Remote management shall be used as much as possible for fault detection, isolation, diagnosis, recovery, and software upgrade installations and testing.

H. Maintenance techniques, equipment and spares so that upgrades, tests, and repairs can be performed without impacting the operations of the observing station.

I. The data logger should include diagnostic tools to facilitate real-time fault isolation to maintain the observing station in operational status.

J. Develop a communication restoration plan in coordination with the Government.

13 Documentation

Extensive metadata are required for each site. This metadata will include site physical information, complete sensor information including sensor serial numbers, calibration dates, siting, and exposure information including digital photographs of sites, etc.

A. NWS will maintain and enhance the current Cooperative Station System Accountability (CSSA) metadata system and users handbook. The CSSA will be available for the contractor to insert relative metadata. The detailed metadata of each station shall be documented in the NWS CSSA. The CSSA is government provided and operated. The contractor must provide the metadata to the NWS through the CSSA. The CSSA Users Handbook describes the metadata in detail.

B. Logistics, installation and maintenance shall be defined and executed based upon the following contractor-supplied documents: Logistics support plan, installation and acceptance checklists, system operations and training manuals, and maintenance manuals.

14 Training

The contractor will provide training materials for observer and WFO staff. The training materials must be detailed enough to provide the observer and the NWS the basic knowledge to operate an observing station.

15 Technical Documents

The Contractor must supply the NWS with all relevant technical documents including (but not limited to) basic drawings of instruments, supply catalogs, specification documents, repair and operations documents, and documentation for software algorithms.

16 Theory of Operations

The contractor must provide the NWS all of the characteristics of the observing system including the ability of the data logger to accept new sensors, the expected life-cycle, and the calibration and maintenance requirements.

17 Supplies Depot

The contractor is responsible for maintaining supplies and replacement sensors. There must be adequate spare parts available to maintain each station. Support ability criteria shall be imposed on sensor selection and data logger designs to minimize the life cycle costs.

18 Sensor Calibration

A sensor calibration lab should be used by the contractor.

19 Availability

The availability of each observing station is defined by the station's data availability to the end user. Sensor availability is defined by each sensor's data being available to the end user, while the availability of the network is defined by the network data availability.

19.1 Observing Station's Data Availability

Observing Station Availability (A_O) is defined as the average proportion of time that a station is operable. (A_O) is calculated monthly using the following equation:

$$A_O = \frac{MTBF - MOT}{MTBF}$$

where,

MTBF = Mean Time Between Failures or Outages = $\frac{\text{Number of Operating Hours}}{\text{Number of Outage Events}}$

MOT = Mean Outage Time (in hours) = MTTR + MSRT + MMDT + MOLDT

where,

MTTR = Mean Time To Repair, including fault isolation, removal and replacement, checkout, and restart time.

MSRT = Mean Supply Response Time waiting for arrival of required spare parts at an observing station.

MMDT = Mean Maintenance Delay Time waiting for the arrival of maintenance personnel at a site.

MOLDT = Mean Other Logistics Delay Time awaiting test equipment, documentation, more highly trained personnel, or any other delay in returning to operational status.

For the purpose of calculating (A_O), outage time will not include routine scheduled maintenance (e.g., cleaning sensor), provided it is infrequent and does not occur during weather when the parameter is critical. Each individual station shall have a minimum overall operational availability (A_O) of 96%. A station is considered operational, if it has produced all the required reports with all the sensor data and staged them to the communications port by the specified time. No outage will be ascribed to a failure of common communication carrier that is outside of

the control of the National Cooperative Mesonet. Requirements for maintenance actions will follow the restoration schedules developed in Section 12.B.

19.2 Sensor Data Availability

Sensor Data Availability (A_S) is defined as an averaged probability that the sensor is operable over a period of time. Sensor A_S is calculated monthly using the same equation as for A_O. Maintenance action for individual sensors will follow restoration priorities as described in Section 12.B.

19.3 Network Data Availability

The data availability for National Cooperative Mesonet network must be 96%. The goal is for 98%. Data availability is defined as the ratio of the actual number of data records that are available to users within the specified transmission time lines divided by the total number of data records that would be available if all stations reported all required reports on time. The data availability is computed using a monthly average.

20 Operating Zones

The sensors must work in a variety of environments. For the purposes of this document, environmental conditions are designated as one of four operating zones. The operating zone conditions may further be grouped into two ranges: standard and extended. The standard range would typically be wide enough to contain the environmental stresses 99% of the time. Sensors should operate reliably and within sensor performance specifications under prolonged exposures to the standard range of environmental conditions. The extended range is an attempt to place an outer limit on the environmental stresses under which the instrument suite will survive. Sensors may not function reliably and/or the measured data may not be accurate, while operating in the extended range. The sensors should automatically return to full performance after exposure to the extended conditions has ended and the environmental conditions return to the standard range. If a specific value for an extended range is not indicated, then the extended range can be assumed to be the same as the standard range.

A. NWS Standard Environmental Criteria and Test Procedures, WS-STD-2, Oct. 8,1984 - describes the procedures used to verify compliance with environmental conditions.

Table 1. Operating zone conditions.

Zone Condition Limits	Extreme	Extreme Cold	Extreme Warm	Moderate
Min Temperature (Standard / Extended)	-57 / -65°C	-51 / -65°C	-29 / -40°C	-29 / -40°C
Max Temperature (Standard / Extended)	60 / 66°C	50 / 60°C	60 / 66°C	50 / 60°C
Snow Load (Standard)	235 kg m^{-2}	235 kg m^{-2}	25 kg m^{-2}	25 kg m^{-2}
Wind Steady (Standard / Extended)	16 / 38 m s^{-1}	16 / 38 m s^{-1}	16 / 38 m s^{-1}	16 / 38 m s^{-1}
Wind Gusts (Standard / Extended)	24 / 50 m s^{-1}	24 / 50 m s^{-1}	24 / 50 m s^{-1}	24 / 50 m s^{-1}
Ice accretion (Standard)	25 mm	25 mm	2.5 mm	2.5 mm
Relative Humidity (Standard / Extended)	74% @ 35°C / 45% @ 43°C	74% @ 35°C / 45% @ 43°C	74% @ 35°C / 45% @ 43°C	74% @ 35°C / 45% @ 43°C
100% Humidity (Standard / Extended)	27 / 29°C	27 / 29°C	27 / 29°C	27 / 29°C
Elevation Range (Standard)	0 to 3,700 m	0 to 3,700 m	0 to 3,000 m	0 to 3,000 m

B. NWS will designate each site as operating in one of 4 operating zones, with the required standard and extended operating range as defined in Table 1.

i. All sensor and data logger performance specifications in this PFRD shall be met when operating within the standard operating range defined for the zone where the station is located.

ii. All sensor and data logger performance specifications in this PFRD shall be met, with the exception of data availability and data accuracy requirements when operating outside the standard operating range but within the extended operating range defined for the zone where the station is located.

iii. The system shall not suffer any permanent damage when operating within the extended range for the zone where the station is located and will return to normal operations when the conditions return to within the standard range.

21 Transportability and Storage

The National Cooperative Mesonet equipment must be capable of surviving normal shipping and storage conditions without damage.

A. NWS Standard Environmental Criteria and Test Procedures, WS-STD-2, October 8, 1984 - describes the procedures used to verify compliance with environmental conditions.

B. All system components shall be transportable via commercial shipping.

C. All system components, when transported or in storage, shall meet all requirements of this specification after exposure to any combinations of the conditions in Table 2.

Table 2. Transport conditions.

Transport Conditions	
Temperature	-65 to 66°C
Humidity	Up to 100% @ 30°C
Precipitation	76 mm h^{-1} @ 16 m s^{-1}
Altitude	-150 to 4,600 m MSL
Vibration	3-5 Hz with acceleration of 9.8 m s^{-2}
Handling (Transit)	Up to 0.8 m drop

22 Flexibility and Expansion of System

The station equipment design shall be modular to allow various components to be plugged in without modification. For example, one should be able to replace one type of temperature sensor with a different type of sensor without making significant changes to the data logger. The software operating in the data logger shall easily permit adding or changing sensor algorithms, sampling periods and other software associated with sensors or communication devices.

23 Design and Construction

The data logger, sensors and communication devices shall be constructed of COTS parts to the maximum extent possible.

24 Human Engineering

The operator-hardware and operator-software interfaces will be designed to maximize safety, efficiency, and usability, and minimize the number of personnel resources, skills, and training required.

25 System Security

The data logger shall be capable of selectively denying access to data while meeting all data collection and processing requirements. Access to the data logger shall be password protected.

26 Data Logger Resource Reserve Capacity

The design and installation of the data logger storage, processing, communication and sensor

interfaces equipment shall be such that equipment modifications may be readily made after the initial installation to meet the growth requirements. The data logger shall have a capacity for 100 percent built in growth margin over the data logger baseline requirements as described in Section 9. The data logger hardware, software, and memory must have the capacity to be expanded through modular add-on data logger hardware. These add-ons to the baseline data logger will provide enhanced transmission and ingest processes, and allow for a total of twenty-four sensors/communication devices, acquired by the contractor to meet expanding requirements of specific sites. The requirements for the data logger with the add-ons are the same as those described in Section 9.

27 Precedence

The requirements in this specification are not of equal importance. The weighting factors incorporated in this specification:

1. *Shall, will, is,* or *must* designates the most important weighting level; (i.e. mandatory). Any deviations from these contractually imposed mandatory requirements require the approval of the contracting officer.

2. *Should* or *may* designates requirements requested by the government and are not mandatory. Unless required by other contract provisions, noncompliance with the "*should"* or *"may"* requirements does not require approval of the contracting officer.

28 Verification and Quality Assurance Provisions

TBS (insert applicable NWS test documents from the reference document list)

28.1 General Requirements

28.1.1 Verification

The contractor is responsible for performing acceptance verification tests. The government is responsible for developing an Operational Acceptance Test (OAT) plan. The Government will monitor and assess the contractor's acceptance verification tests in coordination with the contractor.

A. The system shall be designed so that all requirements contained herein can be verified as specified in Section 28.1.2.

B. Verification shall be carried out in accordance with approved procedures. (See applicable contract requirements to determine which procedures require government approval.) In the case of verification by test (as defined in Section 28.1.2.2), the procedure shall identify the specific test instrumentation (hardware and/or software) and/or special test equipment used.

C. Requirements of Sections 3 through 26 shall be verified by the methods specified for each requirement in the contractor's "System and Segment" specifications as shown in the contractor's Verification Matrix.

D. The verification methods used shall be in accordance with the methods specified in Section 28.1.2.

28.1.2 Verification Methods

28.1.2.1 Demonstration

Demonstration is an exhibition of the ability to operate and/or support an item under intended service use conditions. Sufficient data for requirements verification can be obtained by observing functional operation of the system, or a part of the system, without the use of instrumentation or special test equipment beyond that inherently provided in the system being verified.

28.1.2.2 Test

Test is the verification method by which the operability, support ability, performance capability or other specified qualities of an item are verified when subjected to controlled conditions, real or simulated. These verifications may require use of special test equipment and instrumentation that are not an integral part of the system being verified to obtain quantitative data for analysis, as well as qualitative data derived from displays and indicators inherent in the item(s) for monitor and control.

28.1.2.3 Analysis

Analysis is the verification method used to verify requirements by determining qualitative and quantitative properties and performance of the system by studying and examining engineering drawings, software, and hardware flow diagrams, software and hardware specifications, and other software and hardware documentation (e.g., COTS vendor documentation). It also includes performing modeling, simulation, and/or calculations and analyzing the results. Analysis techniques include interpretation or interpolation/extrapolation of analytical or empirical data collected under defined conditions or reasoning to show theoretical compliance with requirements.

28.1.2.4 Inspection

Inspection is the verification method used to verify characteristics of an item by inspecting engineering documentation produced during development or by inspection of the product itself to verify conformance with specified requirements. Inspection is nondestructive and consists of visual inspections or simple measurements without the use of precision measurement equipment. The Government may conduct inspection testing at the vendors facility in coordination with the contractor.

28.1.2.5 Similarity

Similarity is the process of comparing a current item with a previous item taking into consideration configuration, test data, application and/or environment. The evaluation should be

documented and shall include: the test procedures/reports of the item to which similarity is claimed; a description of the difference(s) between the items; and the rationale for verification by similarity.

28.1.2.6 Records

Complete records indicating relevant verification data, including the application of all parts, materials, and control requirements The verification procedures required by this section, and all nonconformance reports, if any, shall be maintained for the system items and made available for review during the service life of the system.

28.2 Qualification Test Requirements

A. Similarity analysis may be used in lieu of the test or demonstration methods for qualification of a system element when it can be shown the item is identical in design to an item previously qualified to equivalent or more stringent criteria.

B. If similarity analysis cannot be used, qualification shall be in accordance with Section 28.3.

C. Verification shall be carried out in accordance with a verification procedure approved by the Government.

D. In the case of verification by test, the procedure shall identify the test instrumentation (hardware and/or software) and/or special test equipment used.

E. One of each type of sensor shall be subject to qualification testing conducted by the contractor.

28.3 Acceptance Test Requirements

A. Base resource requirements shall be verified at acceptance testing, and will comprise the projected capacity (sensor performance, data logger memory, storage, processing speed, transmission speed, etc.) required to deliver reports from the full complement of National Cooperative Mesonet stations.

B. All of the equipment required for one fully capable observation station shall be subject to end-to-end acceptance testing conducted by the contractor.

C. The system shall be subjected to end-to-end acceptance testing by the Government.

D. The system acceptance criteria shall verify all performance requirements have been satisfied. The Government and the contractor shall jointly agree on acceptance.

E. The contractor shall certify system readiness to begin the Government's operational acceptance test.

29 Preparation for Delivery

A. Deliverable items shall be packed and handled in such a manner as to protect them against vibrations, shocks, moisture, or contamination.

B. Protection shall be provided against natural environmental conditions.

C. Provisions for inspection and handling shall exist for all deliverable items.

29.1 Lot Numbers

The production lot numbers assigned to the types and designations of various categories of sensor (i.e., serial numbers) shall conform to the following code pattern:

TT-DDDDD-YY-JJJ

where:

TT = prefix letters indicating the sensor type,

DDDDD = prefix letters indicating the sensor designation,

YY = two digits, 00 through 99, the last numbers of the calendar year in which the sensor was produced,

JJJ = a three digit number beginning with 001 representing the Julian date of the first day of the final step of the production for the lot.

29.2 Marking of Shipment

The exterior of each National Cooperative Mesonet package and each shipping container shall be clearly marked to identify its contents.

Appendix A. Enhanced Site Standard

This Appendix describes the National Cooperative Mesonet Enhanced Site Standards with sensors beyond the National Cooperative Mesonet Baseline Site Standards. The algorithms, including sampling periods, are in Appendix B. Whenever an element is added to the baseline system, the standards in this Appendix shall be followed. The sensors required for any of these elements will meet the standards described herein. The contractor will acquire and install any sensors for Enhanced sites as an option to the contract as instructed. A site layout plan will be coordinated between the contractor and the Government. Additional elements may be included in this Appendix at a later time.

A1 Soil Temperature

The United States Department of Agriculture (USDA) requirement is for soil temperature to be measured at 5 cm, 20 cm, and 51 cm below the surface of the ground. The goal is for additional measurements at 10 cm and 102 cm. Where it is not possible to get the deeper depths, installation should follow the depth guidelines beginning at the 5 cm and proceeding downward until hitting bedrock.

A1.1 Soil Temperature Accuracy/Resolution

The range of measurement for soil temperature is -10°C to 65°C. The accuracy and resolution requirements are provided in Table A-1.

Table A-1. Soil temperature accuracy/resolution.

Parameter	Units	Accuracy	Range	Resolution
Soil Temperature	Degrees Celsius	±0.6°C	-10 to 65°C	0.06°C

A1.2 Soil Temperature Siting Requirements

The site for soil moisture measurements should be a level plot of ground of about 2 square feet in soil typical of the surrounding ground.

A1.3 Soil Temperature Algorithm

This data shall be reported at least once an hour as an hourly average on the H+60 National Cooperative Mesonet 5-minute report. The data may be sent out more often than once an hour. This algorithm shall be used until superseded. To obtain the hourly report:

A. Average 4 samples per hour that are acquired at the rate of a single instantaneous value every 15 minutes beginning at H+00.

   i. The 15-minute sample is the instantaneous sensor value every 15 minutes.

   ii. Average the four instantaneous samples.

B. The average will be reported as the hourly soil temperature.

A2 Soil Moisture

The USDA requirement is for soil moisture measurements at 5 cm, 20 cm, and 51 cm below the surface of the ground. The **goal** is for moisture measurements additionally at 10 cm, and 102 cm. Not all locations will accommodate all depths. Where it is not possible to reach the deeper depths, installation should follow the depth guidelines beginning at the 5 cm level and proceeding downward until hitting bedrock. Soil moisture and soil temperature shall use the same sensor.

A2.1 Soil Moisture Accuracy/Resolution

The range of measurement for soil moisture is zero to 100%. The accuracy and resolution requirements are provided in Table A-2.

Table A-2. Soil moisture accuracy/resolution.

Parameter	Units	Accuracy	Range	Resolution
Soil Moisture	TBD	±0.03 (Fraction of water by volume)	Zero to 100%	0.5% over the full scale

A2.2 Soil Moisture Siting Requirements

The site for soil moisture measurements should be a level plot of ground of about 0.6 meters square in soil typical of the surrounding ground. The composition of the soil must be provide as part of the metadata. Specialized care must be used during installation to avoid creating water channels to the sensors.

A2.3 Soil Moisture Algorithm

This data shall be reported at least once an hour as an hourly average on the H+60 National Cooperative Mesonet 5- minute report. The data may be sent out more often than once an hour. This algorithm shall be used until superseded. To obtain the hourly report:

A. Average 4 samples per hour that are acquired at the rate of a single instantaneous value every 15 minutes beginning at H+00.

   i. The 15 minute sample is the instantaneous sensor value every 15 minutes.

   ii. Average the four instantaneous samples.

B. The average will be reported as the hourly soil moisture.

A3 Relative Humidity

The USDA requirement is for an element to report relative humidity information in order to

compute evaporative data.

A3.1 Relative Humidity Accuracy/Resolution

The range of measurement for relative humidity is zero to 100%. The accuracy and resolution requirements are provided in Table A-3.

Table A-3. Relative humidity accuracy/resolution.

Parameter	Units	Accuracy	Range	Resolution
Relative Humidity	Percent	±3%	0.8 to 100% non-condensing water vapor	1% over the full scale

A3.2 Relative Humidity Siting Requirements

The site for relative humidity is the same as for a temperature sensor. Refer to the PFRD.

A3.3 Relative Humidity Algorithm

This data shall be reported at least once an hour as a current report at the H+00 report and an hourly average report on the H+60 National Cooperative Mesonet 5-minute report. The data may be sent out more often than once an hour. This algorithm shall be used until superseded.

A. To obtain the current report. Collect a 1-minute relative humidity every minute, beginning with H+01. A 1-minute relative humidity is obtained by:

i. Sampling the relative humidity at least every 10 seconds for each minute.

ii. Average the samples.

iii. Every 5th minute, report the 1-minute relative humidity as the 5-minute relative humidity report.

B. To obtain the hourly average:

i. Average the sixty 1- minute reports beginning with the report collected at H+01.

ii. Report the hourly average of relative humidity on the H+60 5 minute transmitted National Cooperative Mesonet report.

A4 Solar Radiation

The USDA requirement is for an element to report solar radiation data, necessary to compute evaporative data.

A4.1 Solar Radiation Accuracy/Resolution

The wavelength for solar radiation is 400 to 1100 nanometers (nm). The accuracy and resolution requirements are provided in Table A-4.

Table A-4. Solar radiation accuracy/resolution.

Parameter	Units	Accuracy	Range	Resolution
Solar Radiation	W m^{-2} (sensitivity 0.2 kW m^2 V^{-1})	±5% of the reading	0 to 1400 W m^{-2}	1 W m^{-2} over full scale

A4.2 Solar Radiation Siting Requirements

The site for solar radiation is for freedom from obstructions to the solar beam at all times and seasons of the year. The siting shall be selected so the incidence of restrictions to visibility will be typical of the surrounding area.

A4.3 Solar Radiation Algorithm

This data shall be reported at least once an hour as an hourly average report on the H+60 National Cooperative Mesonet 5-minute report. The data may be sent out more often than once an hour. This algorithm shall be used until superseded.

A. Collect a 1-minute solar radiation value every minute, beginning with H+01. A 1-minute solar radiation value is obtained by:

   i. Sampling the solar radiation value at least every 10 seconds for each minute.

   ii. Average the samples for the minute.

B. To obtain the hourly average:

   i. Average the sixty 1-minute reports beginning with the report collected at H+01.

   ii. Report the hourly average of solar radiation value on the H+60 5-minute transmitted National Cooperative Mesonet report.

A5 Wind

The USDA requirement is for a wind element to compute evaporative data.

A5.1 Wind Speed Accuracy/Resolution

The range of measurement for wind speed is 0 to 60 meters per second. The accuracy and resolution requirements are provided in Table A-5.

Table A-5. Wind speed for evaporation accuracy/resolution.

Parameter	Units	Accuracy	Range	Resolution
Speed and Character	m s^{-1}	±0.3 m s^{-1} above 1.0 m s^{-1}	0 to 60 m s^{-1}	0.4 m s^{-1} over entire scale

A5.2 Wind Direction Accuracy/Resolution

The range of measurement for wind direction is 1 to 360 Degrees. The accuracy and resolution requirements are provided in Table A-6.

Table A-6. Wind direction for evaporation accuracy/resolution.

Parameter	Units	Accuracy	Range	Resolution
Direction	degrees	±3 degrees	1 to 360 degrees	1 degree over full scale

A5.3 Wind Siting Requirements

The sensor to meet this requirement should be on a tower with exposure to provide an unobstructed wind field. The NWS instruction 10-1302 provides standards for exposure for wind fields. The sensor should be mounted at a height of 2 meters. There may be mathematical coefficients applied to appropriately account for sensor height on a tower.

A5.4 Wind Speed Algorithm

This data shall be reported at least once an hour as a current report, an hourly maximum, and an hourly average. The current shall be reported at the H+00 report. The maximum and hourly shall be reported on the H+60 National Cooperative Mesonet 5-minute report. A daily 24-hour average wind speed shall be reported. The daily 24 hour average shall be reported on the H+60 National Cooperative Mesonet 5-minute report as a data field in the report in the midnight local time report. The current data may be sent out more often than once an hour. This algorithm shall be used until superseded.

A. To obtain the current report. Collect a 1-minute wind speed every minute, beginning with H+01. To obtain the 1- minute wind speed:

   i. Sample the wind speed at least every 10 seconds for each minute.

   ii. Average the samples each minute.

B. To obtain the maximum hourly wind speed:

   i. Sample the wind speed every 10 seconds beginning at H+01.

   ii. Determine the maximum wind speed from the three hundred and sixty 10-second samples.

iii. Report the hourly maximum wind speed on the H+60 5-minute transmitted National Cooperative Mesonet report.

C. To obtain the hourly average:

i. Average the sixty 1-minute reports beginning with the report collected at H+01.

ii. Report the hourly average of wind speed on the H+60 5-minute transmitted National Cooperative Mesonet report.

D. To obtain the 24-hour average wind speed report:

i. Average of the 24 hourly reports.

ii. Report the 24-hour average wind speed at midnight local time on the H+00 5-minute transmitted National Cooperative Mesonet report.

A5.5 Wind Direction Algorithm

This data shall be reported at least once an hour as a current report and an hourly average. The current shall be reported at H+00. The hourly shall be reported on the H+60 National Cooperative Mesonet 5-minute report. A 24-hour average wind direction vector shall be reported. The 24-hour average shall be reported on the H+60 National Cooperative Mesonet 5-minute report at midnight local time report. The goal is to report data on a 15-minute frequency. This algorithm shall be used until superseded

A. To obtain the current report. Collect a 1-minute wind direction every minute, beginning with H+01. To obtain the 1-minute wind direction:

i. Sample the wind direction at least every 10 seconds for each minute.

ii. Compute a vector average from the samples each minute.

iii. Report the current wind direction on the H+00 5-minute transmitted National Cooperative Mesonet report.

B. To obtain the hourly average:

i. Compute a vector average from the sixty 1-minute reports, beginning with the report collected at H+01.

ii. Report the hourly average of wind direction on the H+60 5-minute transmitted National Cooperative Mesonet report.

C. To obtain the 24-hour average wind direction report:

i. Average of the 24 "average hourly wind direction" reports.

ii. Report the 24-hour average wind direction at midnight local time on the H+00 5-minute transmitted National Cooperative Mesonet report.

D. To achieve the 15 minute goal:

i. Report the current wind direction on the H+00 5-minute transmitted National Cooperative Mesonet report and every 15 subsequent minutes.

ii. Compute a vector average from the 15-minute wind direction reports:

a. Compute a vector average from the 1-minute wind directions every 15 minutes, and

b. Report the 15 minute average wind direction on the H+00 5-minute transmitted National Cooperative Mesonet report and every 15 subsequent minutes.

A6 Barometric Pressure

The optional requirement is for a station barometric pressure element.

A7 Barometric Pressure Accuracy/Resolution

The range of measurement for barometric pressure is 600 to 1060 millibars (mb). The accuracy and resolution requirements are provided in Table A-7.

Table A-7. Barometric pressure accuracy/resolution.

Parameter	Units	Accuracy	Range	Resolution
Barometric Pressure	hPa or mb	±0.5 mb	600 mb to 1060 mb	0.3 mb over full scale

A7.1 Barometric Pressure Siting Requirements

The exposure of the pressure sensor should be protected from windy conditions but available to the natural atmosphere.

A7.2 Barometric Pressure Algorithms

This data shall be reported on each National Cooperative Mesonet 5-minute report. This algorithm shall be used until superseded. To obtain the current report, collect a 1-minute barometric pressure every minute, beginning with H+01. To obtain the 1-minute barometric pressure:

A. Sample the barometric pressure at least every 10 seconds for each minute.

B. Average the samples for each minute.

C. Every fifth minute, report the 1-minute barometric pressure as the current 5-minute barometric pressure. Ensure that the report is transmitted on the 5-minute National Cooperative Mesonet report.

A8 Operational Winds

The optional requirement is for a wind direction, speed and gust element for use in operational forecasting.

A8.1 Operational Winds Accuracy/Resolution

The range of measurement is from 1 to 360 degrees and 1 to 64 m s^{-1}. The accuracy and resolution requirements are provided in Table A-8.

Table A-8. Operational winds accuracy/resolution.

Parameter	Units	Accuracy	Range	Resolution
Direction	degrees	±5 degrees when speed is .2.6 m s^{-1}	1 to 360 degrees	10 degrees
Speed and Character	m s^{-1}	±0.5 m s^{-1} up to 5.1 m s^{-1} ±10% above 5.1 m s^{-1}	1 to 64 m s^{-1}	0.5 m s^{-1}

A8.2 Operational Wind Siting Requirements

The siting and exposure of the operational Wind element shall follow the standards in NWS 10-1302 for climatological standards. The sensors shall be mounted on a 10-meter tower.

A8.3 Operational Wind Algorithm

This data shall be reported on every National Cooperative Mesonet 5-minute report. The data reported shall be the wind speed, direction and character. The algorithms used for operational winds should follow the Algorithms for Automated Surface Observing Systems, dated October 31, 1994, available from the NWS.

A9 Dew Point

The optional requirement is for an element to provide dew point data for use in operational forecasting.

A9.1 Dew Point Accuracy/Resolution

The range of measurement is from -37°C to 30°C. The accuracy and resolution requirements are provided in Table A-9.

Table A-9. Dew point accuracy/resolution.

Parameter	Units	Accuracy	Range	Resolution
Dew Point	Degrees Celsius	±2.2°C ±1.7°C ±1.1°C	-37 to -31°C -31 to -1°C -1 to +30°C	0.06°C 0.06°C 0.06°C

A9.2 Dew Point Siting Requirements

The siting and exposure of the dew point element shall follow the standards for ambient air temperature.

A9.3 Dew Point Siting Algorithm

This data shall be part of the 5-minute National Cooperative Mesonet report.

A. Twelve 5-minute dew point temperature reports every hour. To obtain the 5-minute dew point temperature:

   i. Report a 1-minute dew point temperature every minute, beginning with H+01. To obtain the 1-minute dew point temperature:

      a. Sample the dew point temperature at least every 10 seconds for each minute.

      b. Average the instantaneous samples.

B. Every fifth minute, report the 1-minute dew point temperature as the 5-minute dew point temperature report.

A10 Chemical and Biological Detection

The optional requirement is for a chemical and biological detection element for use in homeland security activities.

A10.1 Chemical and Biological Accuracy/Resolution

The range of measurement are TBD. The accuracy and resolution requirements are provided in Table A-10.

Table A-10. Chemical and biological detection accuracy/resolution.

Parameter	Units	Accuracy	Range	Resolution
Chemical	TBD	TBD	TBD	TBD
Biological	TBD	TBD	TBD	TBD

A10.2 Chemical and Biological Detection Siting Requirements

The siting and exposure of the Chemical and Biological Detection element shall follow the

standards TBD.

A10.3 Chemical and Biological Detection Algorithm

The algorithm is TBD.

A11 Water Vapor Detection

The optional requirement is for a water vapor element for use in operational forecasting and numerical weather prediction.

A11.1 Water Vapor Detection Accuracy/Resolution

The range of measurement are TBD. The accuracy and resolution requirements are provided in Table A-11.

Table A-11. Water vapor accuracy/resolution.

Parameter	Units	Accuracy	Range	Resolution
Water Vapor	TBD	TBD	TBD	TBD

A11.2 Water Vapor Siting Requirements

The siting and exposure of the water vapor element shall follow the standards TBD.

A11.3 Water Vapor Detection Algorithm

The algorithm is TBD.

A12 Amending this Appendix

As additional requirements are presented by the National Weather Service and our partners, this Appendix may be amended.